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Wiles et al.

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(54) **CURABLE ASSEMBLY AND A FILLER COMPONENT**

(75) Inventors: **Gary Wiles**, Isle of Wight (GB); **Peter Michael Baker**, Bristol (GB)

(73) Assignee: **AIRBUS OPERATIONS LIMITED**, Bristol (GB)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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B29C 70/86	(2006.01)
B29K 63/00	(2006.01)
B29K 77/00	(2006.01)
B29K 307/04	(2006.01)

(52) **U.S. Cl.**

CPC ***B29C 70/345*** (2013.01); ***B29C 70/086*** (2013.01); ***B29C 70/86*** (2013.01); *B29K 2063/00* (2013.01); *B29K 2077/00* (2013.01); *B29K 2307/04* (2013.01); *Y02T 50/433* (2013.01); *Y10T 156/10* (2015.01); *Y10T 403/47* (2015.01); *Y10T 428/24479* (2015.01)

(58) **Field of Classification Search**

CPC B29C 70/04; B29C 70/086; B29C 70/34; B29C 70/345; B29C 70/685; B29C 70/86; B29C 66/05; B29C 66/10; B29C 66/43421; B29C 66/43441; B29C 66/474; B29C 66/496; Y02T 50/43; Y02T 50/433; B29K 2307/04; Y10T 156/10; Y10T 428/24479; Y10T 403/47

USPC 428/156; 403/42, 169–178, 204, 205, 403/265

See application file for complete search history.

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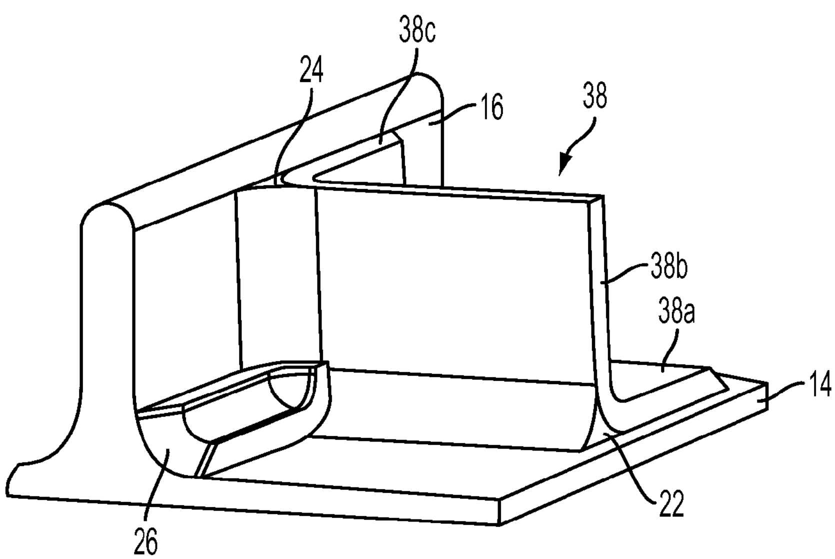
Primary Examiner — Maria Veronica Ewald
Assistant Examiner — Nancy Johnson
(74) *Attorney, Agent, or Firm* — Lowe Hauptman & Ham, LLP

(57) **ABSTRACT**

A curable assembly which upon the application of curing conditions will form a completed component or part component comprises two pieces of composite fiber-reinforced, resin matrix material, with filler component of relatively rigid material arranged therebetween. The intermediate component is arranged to be secured between the two pieces. The filler component has a body with first and second opposing surface profiles. The filler component can be used to transmit or react a consolidating load during curing.

14 Claims, 7 Drawing Sheets



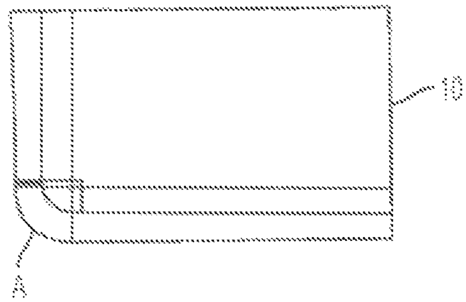


FIG. 1a (PRIOR ART)

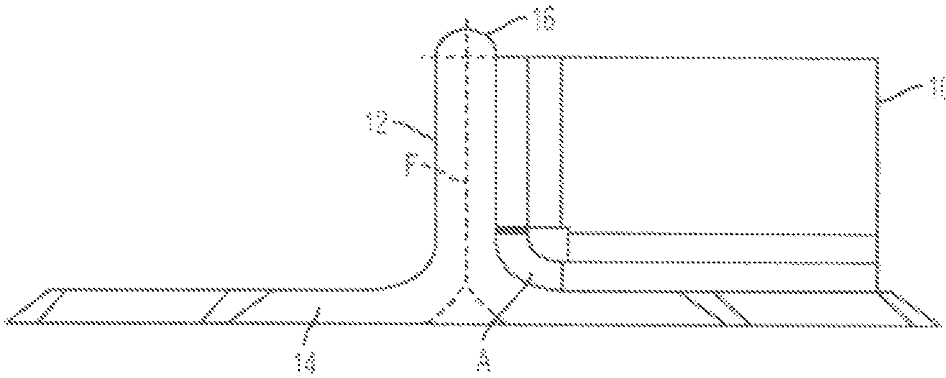


FIG. 1b (PRIOR ART)

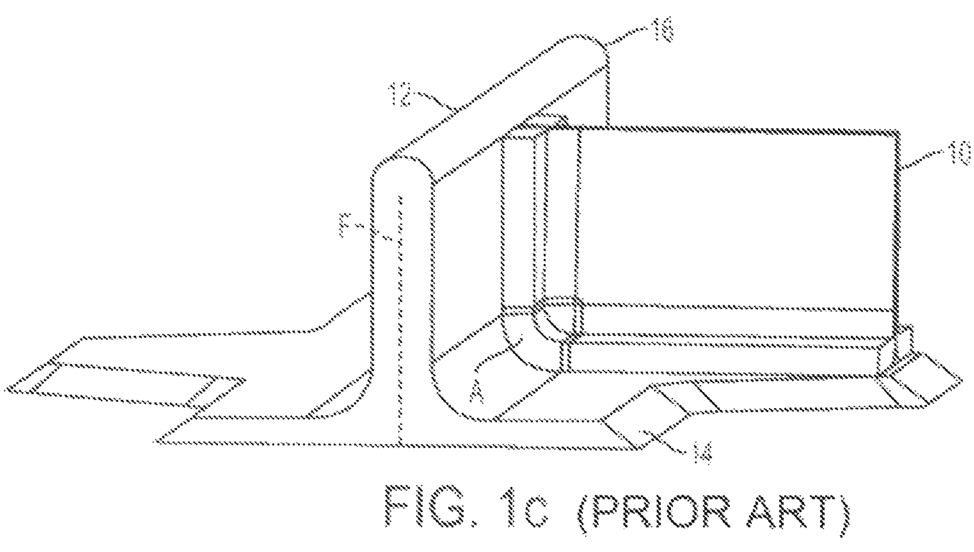


FIG. 1c (PRIOR ART)

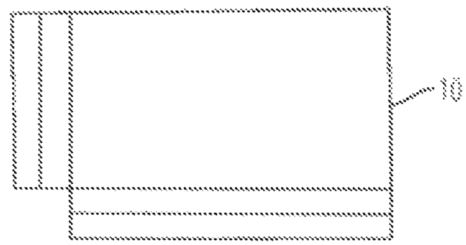


FIG. 2a (PRIOR ART)

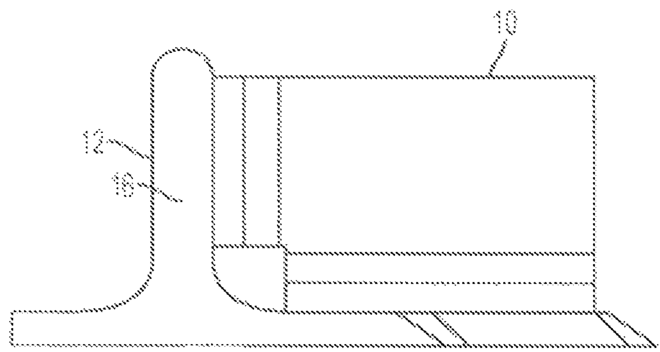


FIG. 2b (PRIOR ART)

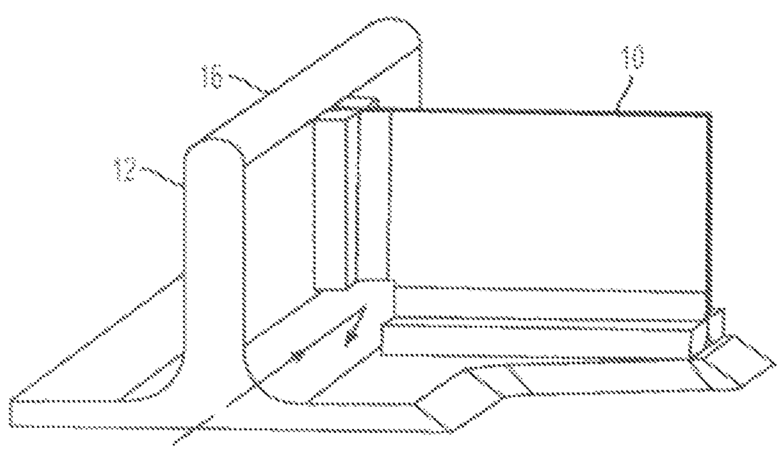


FIG. 2c (PRIOR ART)

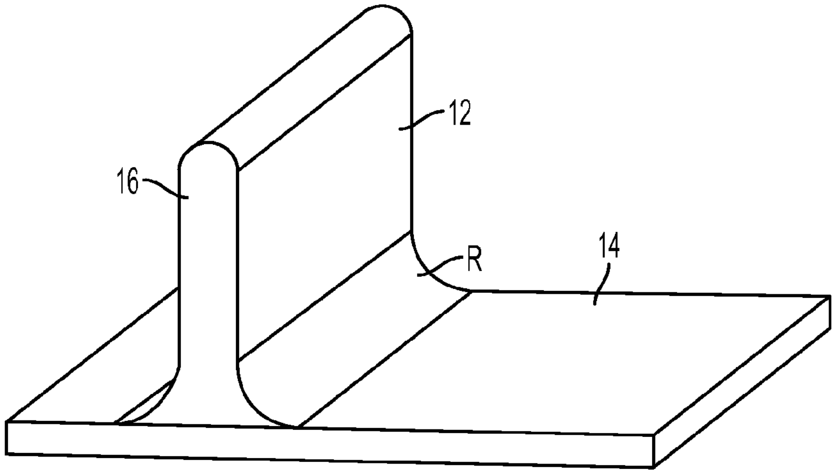


FIG. 3

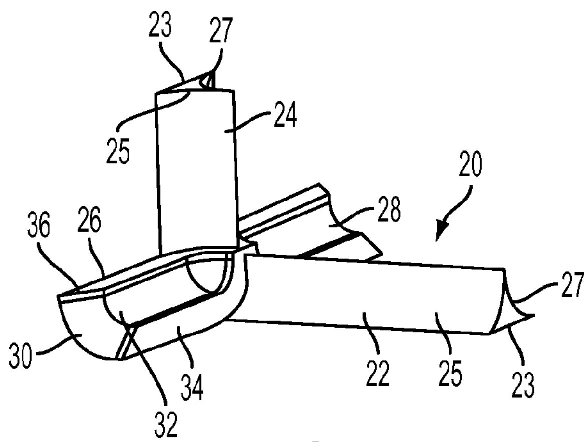


FIG. 4

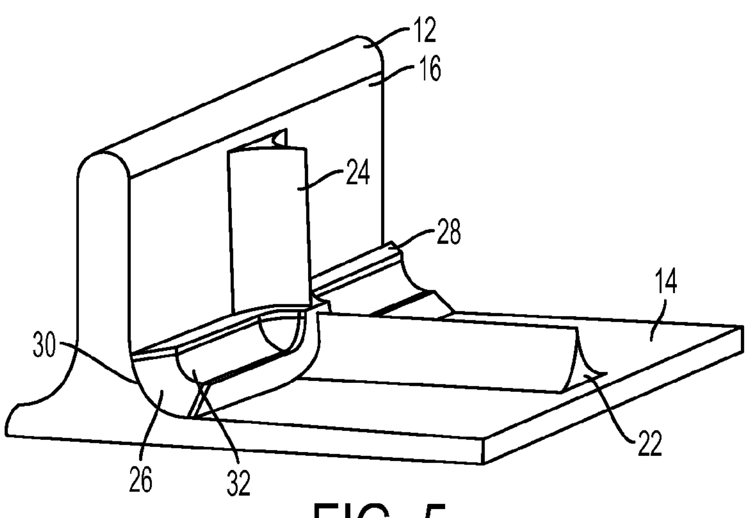


FIG. 5

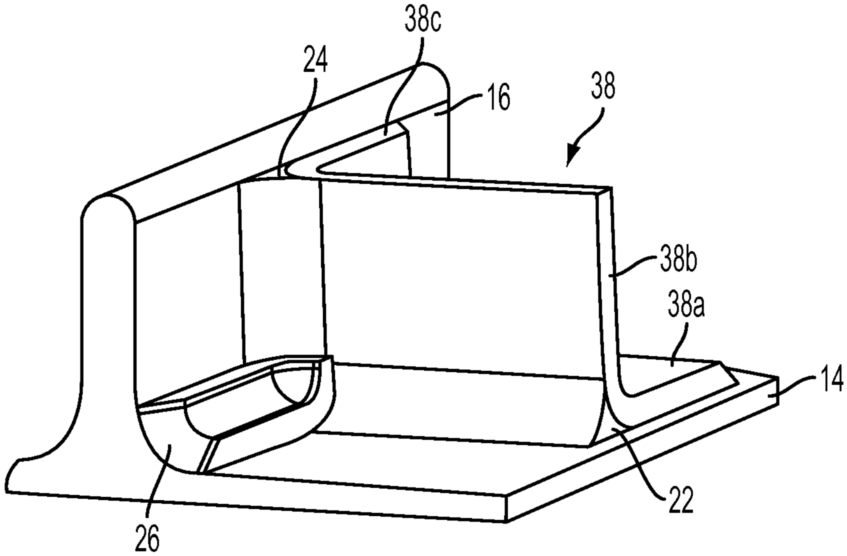

38c
24
16
38
38b
38a
14
22
26

FIG. 6

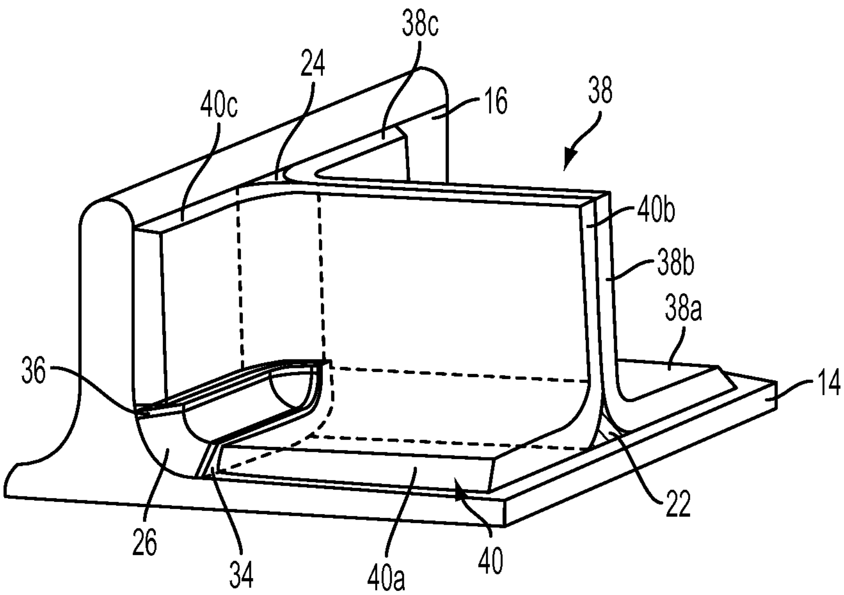

38c
24
40c
16
38
40b
38b
38a
36
14
22
26
34
40a
40

FIG. 7

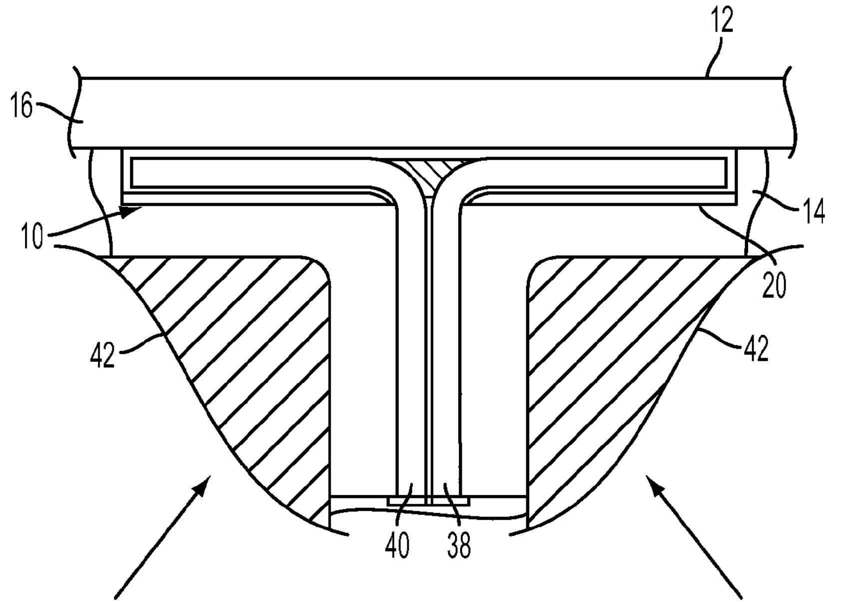

12
16
14
10
20
42
42
40
38

FIG. 8

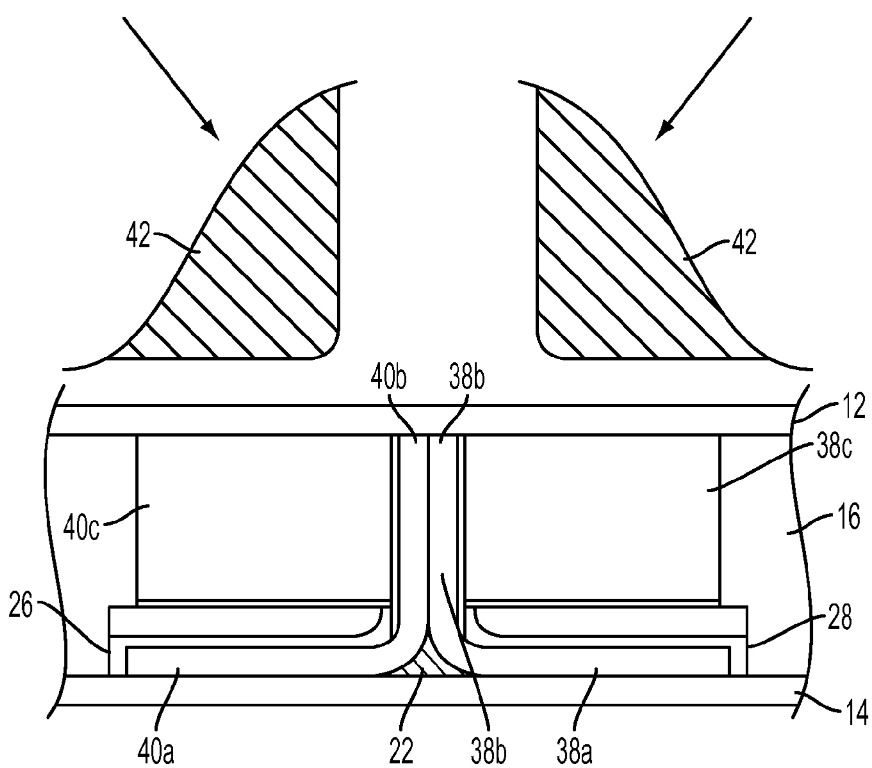

42
42
40b
38b
12
38c
40c
16
26
28
14
40a
22
38b
38a

FIG. 9

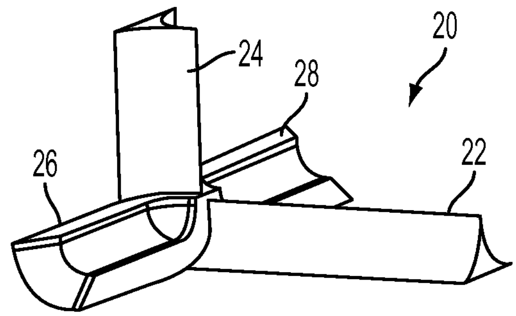


FIG. 10a

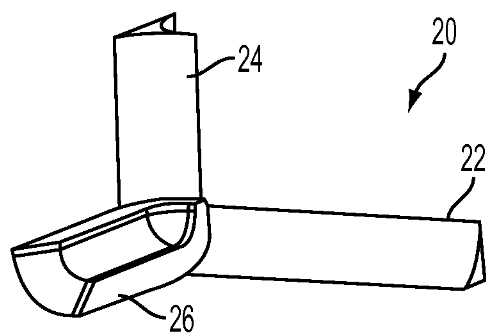


FIG. 10b

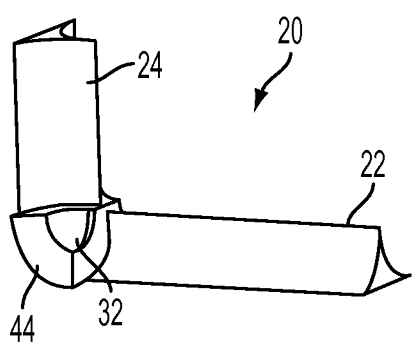


FIG. 10c

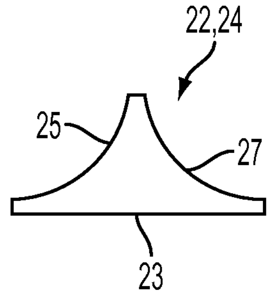


FIG. 11a

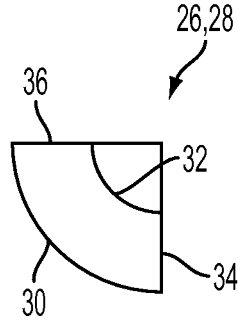


FIG. 11b

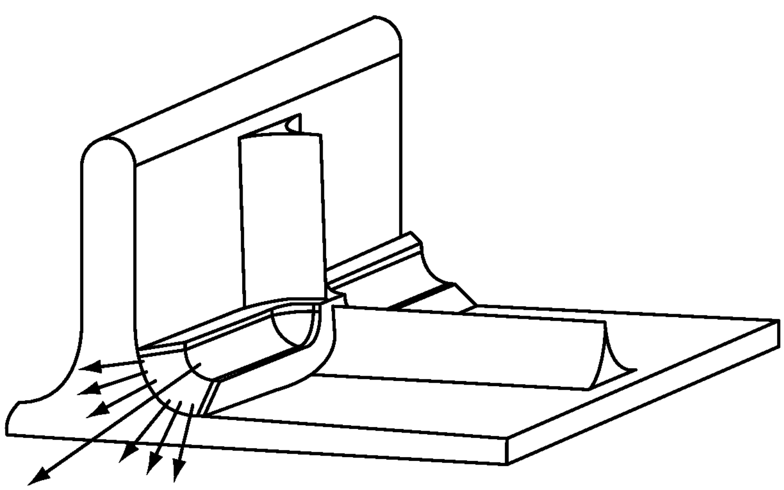


FIG. 12

CURABLE ASSEMBLY AND A FILLER COMPONENT

RELATED APPLICATIONS

The present application is based on, and claims priority from, British Application Number 1114997.8, filed Aug. 31, 2011, the disclosure of which is hereby incorporated by reference herein in its entirety.

The present invention relates to the manufacture of composite components, in particular curable composite components for example made from carbon fibre reinforced epoxy resin.

When manufacturing components from composite material, for example, carbon fibre reinforced epoxy resin matrix material, multiple components may be required to be cured simultaneously to provide a single final part. Curing typically requires the application of an elevated temperature for a predetermined time and often the application of a consolidating pressure to assist in curing and to apply a particular profile by means of a die. Where this co-curing of components is necessary, there is a requirement for consistent curing and consolidating conditions across all of the co-cured components. It is important to ensure that there is sufficiently consistent consolidation applied to the curing components to achieve the required quality of final part.

Typically, components are heated and have a consolidating tool applied to them to apply pressure. The tool typically has a die face which applies a particular form to the cured component.

It is important that sufficient consolidation is provided to ensure that the final component thickness is accurate and that the inner quality of the, typically, laminate material in terms of porosity and fibre volume content meets the quality requirements specified for the particular part.

Co-curing of multiple composite components can create the necessity for complex tooling to provide sufficient and consistent consolidation across all components. Such complex tooling can hinder high volume manufacture due to the time taken to set up the parts in the tool and to remove from the tool after the curing. The tooling itself is complex and can be expensive to manufacture and maintain.

It is known when manufacturing "back to back" components to provide "noodles" to fill the void under radii. These are ineffective where a void is formed as a result of darting the laminate or where re-entrant tooling is necessary.

It is an object of the invention to provide an improved curable assembly.

According to the first aspect of the invention there is provided a curable assembly, which, upon the application of curing conditions will form a completed component or part component, the assembly comprising:

a first curable piece of composite fibre-reinforced, resin matrix material,

a second curable piece of composite fibre-reinforced, resin matrix material arranged against the first curable piece,

an intermediate component arranged between the first and the second curable pieces, the intermediate component formed from a rigid material relative to the material of the first and second curable pieces before curing, whereby the intermediate component is arranged to be secured between the first and second curable pieces on application of curing conditions so as to form the completed component or part component.

In that way the issue of any voids between the first and second curable pieces of composite fibre reinforced resin matrix material is addressed by providing the intermediate component. By designing the intermediate component to form part of the completed component, the need to design for removal is eliminated, allowing the use of more complex shapes for the intermediate component to perform additional functions. For example the intermediate component can be used to react or transmit consolidating curing pressure forces applied by a curing tool in spaces previously requiring re-entrant tools.

According to the second aspect of the invention there is provided a filler component configured to be arranged, in use, between first and second curable sub-assembly parts, the filler component having a body defining a first surface having a first profile and a second substantially opposite surface having a second profile, the first surface profile being shaped to fit against the first curable surface assembly part, the second surface profile being shaped to fit against the second curable surface assembly part, the filler component being arranged to apply or to react a tooling load at at least one of the first or second surfaces during curing and wherein the filler component is arranged to remain between the first and the second surface assembly parts after curing.

In that way, rather than using lots of complex tooling to provide consolidation pressure on the co-cured components, the pre-formed shaped filler component acts both as a tooling interface during curing and an integral part of the finished component. This greatly simplifies the tooling required to manufacture complex composite components, removing the requirement for re-entrant tooling.

The filler component is preferably arranged to apply or to react a tooling load at both of the first and second surfaces. The term "apply" includes both direct application of the consolidating load or transmission of the consolidating load from a tool applied to part of the filler component.

The first profile is preferably a radius. The second profile is also preferably a radius. Most preferably, the first radius is larger than the second radius.

Where the first profile is a radius, the first curable sub-assembly may have a corresponding radius that is larger than the first profile radius. Likewise, where the second profile is a radius, the second curable sub assembly may have a corresponding radius which is larger than the second profile radius. In that way, a tighter radius can be provided by the filler component than could be adopted by part of the curable material. On application of the curing consolidation pressure, the curable sub-assemblies are forced into and against the tighter radius of the filler component.

The filler component may be elongate in form, or L-shaped, T-shaped or in a cruciform. Alternatively, the filler component could comprise three mutually orthogonal members as in X, Y and Z axes in a Cartesian reference frame. One or more of the members may pass through the "origin" of the "axis".

The filler component preferably comprises a first elongate member which has a cross section in the form of a concave ogive. That cross section comprises two back to back radiused sides and a flat base. The filler component preferably further comprises a second elongate member arranged at right angles to the first elongate member and having a cross section in the form of a part annulus. The second elongate member is arranged relative to the first elongate member to provide a flat surface against which the curable piece of fibre reinforced epoxy resin matrix material can be arranged. In that way, the curable fibre resin matrix material can be laid up against the second elongate member and can be bent around the radius defined by one of the radiused surfaces of the first elongate member. Most preferably, the filler component comprises two of said first elongate members arranged at right angles to each other and two of said second elongate members extending from the point at which the first elongate members intersect, on opposite sides thereof.

According to a third aspect of the invention there is provided a method of forming a completed component or part component, the method comprising the steps of:

providing a first curable piece of composite fibre-reinforced resin matrix material,

providing a second curable piece of composite fibre-reinforced resin matrix material,

providing an intermediate component formed from material which is rigid relative to the composite fibre-reinforced resin matrix material before it is cured,

arranging the intermediate component between the first and second curable pieces of composite fibre-reinforced resin matrix material to provide a curable sub-assembly,

applying a curing tool to the sub-assembly to apply heat and pressure to the sub-assembly, whereby the intermediate component reacts to pressure applied to the surface assembly to apply consolidating pressure to the face of the composite fibre-reinforced resin matrix material arranged away from the curing tool, and retaining the intermediate component as part of the completed component or part component.

An embodiment of the invention will now be described in detail by way of example with reference to the accompanying drawings, in which:

FIGS. **1***a* to **1***c* are, respectively, an end elevation of an uncured web part of a composite component (FIG. **1***a*), an end elevation of the uncured web part, assembled onto an uncured rib part of a composite component (FIG. **1***b*) and a perspective view of the assembly shown in FIG. **1***b* (FIG. **1***c*),

FIGS. **2***a* to **2***c* are similar views to FIGS. **1***a* to **1***c* respectively but with an alternative design of uncured web part to accommodate a re-entrant curing tool part,

FIG. **3** is a perspective view of an uncured rib part of a composite component,

FIG. **4** is a perspective view of a filler component in accordance with the second aspect of the invention,

FIG. **5** is a perspective view of the filler component of FIG. **4** arranged on the uncured rib part of FIG. **3**,

FIGS. **6** and **7** are similar to FIG. **5** but showing, respectively, one and two sides laid up with a layer of uncured fibre-reinforced resin matrix material,

FIG. **8** is a plan view of the part of the composite component showing the uncured rib part, two uncured web parts and two filler components about to have a curing tool applied to the component,

FIG. **9** is a side elevation of the component of FIG. **8**,

FIGS. **10***a* to **10***c* are perspective views, respectively, of three alternative configurations of filler component,

FIG. **11***a* is an end elevation of one of the web support posts of the filler component of FIG. **10***a*,

FIG. **11***b* is an end elevation of one of the web abutment arms of the filler component of FIG. **10***a* and,

FIG. **12** is a view similar to FIG. **5** showing the application of compressive force via the filler component during curing.

FIGS. **1***a* to **1***c* and **2***a* to **2***c* illustrate part of a known aerospace component made from a composite fibre-reinforced resin matrix material. The aerospace component comprises a series of ribs with strengthening webs extending between the ribs. The ribs and webs are formed from uncured fibre-reinforced resin matrix material and are cured by the application of heat and consolidating pressure from a curing tool which cures the, typically, epoxy resin to produce a final cured component.

FIG. **1***a* shows an uncured web part **10** of a composite aerospace component formed from uncured carbon fibre-reinforced epoxy resin matrix material. The uncured web part **10** has a substantially rectangular form with one radiused corner A.

The uncured web part **10** is arranged against an uncured rib part **12**. The uncured rib part **12** comprises a rib base **14** and an upstanding rib wall **16** protruding from the base. The radiused corner A of the uncured web part **10** is designed to fit snugly into the radiused transition R from the rib base **14** to the rib wall **16**.

There can be difficulties in ensuring consistent curing consolidation pressure and temperature distribution in the radiused corner A as the depth of material at the corner A is the greatest in the uncured assembly. Ensuring that sufficient consolidation pressure passes through the corner A into the rib part **12** beneath the corner is problematic.

One approach is shown in FIGS. **2***a* to **2***c* in which all the parts are substantially identical to the parts shown in FIGS. **1***a* to **1***c* and carry the same reference numerals. The uncured web part **10** in FIG. **2***a* has the corner part, which was radiused in FIG. **1***a*, cut away. The removal of that material in the corner of the uncured web part **10** allows space for a curing tool (not shown) to apply consistent consolidation and pressure to the radiused transition R between the rib base **14** and the rib wall **16**. FIGS. **2***b* and **2***c* show that void where a re-entrant tool can be inserted to apply the curing temperature and consolidation pressure. Whilst that arrangement solves the problem of ensuring the even application of consolidation pressure to the radiused transition from rib base to rib wall by the use of a re-entrant tool, it does mean that a void exists in that area once the part is cured. Also, arranging a re-entrant curing tool into all of the voids across multiple web parts and rib parts is complicated and removal of the cured part from the curing tool is time consuming.

A curable assembly in accordance with the first aspect of the invention and a filler component in accordance with the second aspect to the invention solves the problem of even curing consolidation pressure and eliminates the need for re-entrant tooling.

In FIG. **3**, an uncured rib part **12** of the composite aerospace component formed of composite carbon fibre-reinforced epoxy resin matrix material is shown. As in FIGS. **1** and **2**, the uncured rib part **12** comprises a rib base **14** and a rib wall **16**.

In FIG. **4**, a filler component **20** in accordance with the second aspect of the invention is shown. The filler component **20** comprises two web support posts **22**, **24** at right angles to each other and two web abutment arms **26**, **28** extending from opposite sides of the point of intersection of the web support posts **22**, **24**.

The web support posts **22**, **24** each have elongate substantially prismatic bodies which in cross section have the form of a concave ogive, having three sides **23**, **25**, **27**, one of which is flat **23** and two sides **25**, **27** each having the form of a part circumference and arranged back to back so as to intersect.

The web abutment arms **26**, **28** have elongate bodies, which, in cross section, have the form of a part annulus. The annulus may describe an angle of 45° to 90°. In the filler component **20** shown in FIGS. **4** to **7** the annulus describes an angle of approximately 60°. The part annulus shape of the cross section of the elongate body provides an outer radiused surface **30**, and in a radiused surface **32**, a side facing flat abutment surface **34** and an upwardly facing flat abutment surface **36**. The outer radiused surface **30** has a radius which is less than the radiused transition R naturally adopted between the rib base **14** and rib wall **16**. The inner radiused surface **32** is arranged to receive part of a curing tool to be described later. The side and upwardly facing flat abutment surfaces **34**, **36** each have a width which is greater than or equal to the thickness of uncured composite carbon fibre-reinforced resin matrix material which is used to form the web part **10** (see FIG. **7**).

FIGS. **5** to **9** and FIG. **12** illustrates the steps in the method according to the third aspect of the invention.

First, the uncured rib part **12** is pre-formed from composite carbon fibre-reinforced epoxy resin material to provide an upstanding rib wall **16** and rib base **14**. Because the material is in its uncured state and no compressive force has been applied to it, the transition between the upstanding rib wall **16** and the rib base **14** has a relatively large radius R.

The filler component **20** of FIG. **4** is an arranged on the uncured rib part **12** so that the outer radiused surfaces **30** of the web abutment arms **26**, **28** lie against the radiused transition R between the rib wall **16** and rib base **14**. The flat side **23** of web support post **22** lies against the upper surface of the rib base **14** and the flat side **23** of the web support post **24** lies against the side surface of the rib wall **16**.

Then a first L-shaped piece of carbon fibre-reinforced epoxy resin matrix material **38** is laid up onto the uncured rib part **12** and filler component **20** so that one part **38***a* of the first L-shaped piece lies on the upper surface of the rib base **14**, a second part **38***b* curves upwardly from the first part **38***a* partially supported by the web support post **22** to extend substantially orthogonally relative to the rib base **14** and rib wall **16**. A third part **38***c* of the L-shaped piece **38** curves away from the second part **38***b* partially supported by the web support post **24** so as to run along and parallel with the rib wall **16** (see FIG. **6**). The radiused transitions between the parts **38***a* and **38***b* and **38***b* and **38***c* respectively follow, as far as possible, the radius of the part circumference sides **27** of the web support posts **22**, **24**. The radiused transitions have a larger radius in the uncured state than the radius of the part circumference side **27**.

A second L-shaped piece of carbon fibre-reinforced epoxy resin matrix material **40** is then laid onto the uncured rib part **12** in a mirror image of the first L-shaped piece. Thus, the second L-shaped piece has one part **40***a* which extends parallel to and on top of the rib base **14**, an upstanding second part **40***b* which extends orthogonal to the rib base **14** and rib wall **16** and a third part **40***c* curved along and parallel with the rib wall **16**. When the second L-shaped piece **40** is arranged on the uncured rib part **12**, the filler component **20** is trapped between the first and second pieces **38**, **40**. The first part **38***a*, **40***a* of the first and second L-shaped pieces abut at one edge, respectively, the side facing flat abutment surfaces **34** of the web abutment arms **26**, **28**. The underside of the third parts **38***c*, **40***c* abut the upwardly facing flat abutment surface **36** of the web abutment arms **26**,**28**. The assembly is then ready to be cured by the application of heat over a pre-determined period of time and a consolidating pressure applied by a curing tool. A simplified example is shown in FIGS. **8** and **9**.

In FIGS. **8** and **9** a curable assembly is shown from above which comprises part of an aerospace component. The curable assembly comprises an uncured rib part **12** having a base **14** on one side of an upstanding rib wall **16**. An uncured web part **10**, made up from first and second L-shaped pieces of uncured composite carbon fibre-reinforced epoxy resin matrix material **38**, **40** are arranged against the rib wall **16**, one web part **10** on each side of the rib wall **16**. Each web part **10** is arranged around a filler component **20** in the manner illustrated in FIG. **7**.

The uncured assembly is then subject to the application of curing heat and consolidating pressure by means of a curing tool **42**. The curing tool **42** comprises a heated die tool having a surface profile which can be imparted to the surface of the composite carbon fibre-reinforced epoxy resin matrix material.

As mentioned above, the inner radiused surface **32** of the web abutment arms **26**, **28** are arranged to receive the inner leading edges of the curing tools **42**. The curing tools **42** compress the uncured assembly both inwardly as shown in FIG. **8** and downwardly as shown in FIG. **9** whilst applying heat for the requisite curing time. During that application of consolidating compressive force, the composite carbon fibre-reinforced epoxy resin matrix material is pushed against the filler component **20** so that the radiused transitions between the parts **38***a* and **38***b*, **38***b* and **38***c*, **40***a* and **40***b*, and **40***b* and **40***c* are pressed against and into the part circumferential faces of the sides **25**, **27** of the web support posts **22**, **24** so that the surfaces of the L-shaped pieces **38** and **40** in those areas assume the radius of those part circumferential sides **25**, **27**.

The curing tools **42** press against the filler components **20** so as to transmit the consolidating compressive force into the radiused transition R between the rib base **14** and the rib wall **16**, as shown in FIG. **12**. The radiused transition R adopts the radius of the outer radiused surface **30** of the web abutment arms **26**, **28** and that pushes the filler component **20** into the surface of the rib part **12**. That, in turn, means that the side and upwardly facing flat abutment surfaces **34**, **36** of the web abutment arms **26**, **28** move from being slightly proud of the parts **38***a*, **38***c*, **40***a*, **40***c* of the first and second L-shaped pieces of composite carbon fibre-reinforced epoxy resin matrix material to flush with them. Thereafter, further movement of the curing tool **42** to effect additional compressive strain acts on both the filler component and the pieces of composite carbon fibre-reinforced epoxy resin matrix material **38**, **40**.

FIGS. **10***a* to **10***c* illustrate various alternative configurations of filler component **20**. In FIG. **10***a* the filler component **20** is as described in the preceding figures. In FIG. **10***b*, the filler component **20** has two web support posts **22**, **24** arranged in an L-shape with a single web abutment arm **26** extending from the intersection of the web support posts **22**, **24**. Each of the web support posts **22**, **24** in FIG. **10***b* has two flat sides and a single part circumferential side. The web abutment arm **26** is as previously described. This filler component may be used in a corner.

In FIG. **10***c* the filler component **20** comprises of two web support posts **22**, **24** as in FIG. **10***a*. A curing tool receiving formation **44** is formed at the point of intersection of the web support posts **22**, **24**. The curing tool receiving formation **44** comprises a truncated web abutment arm **26**, **28** so that the inner radiused surface **32** of the curing tool receiving formation is part spherical.

The present invention has been described in relation to the manufacture of composite carbon fibre-reinforced epoxy resin matrix material articles but it can be applied in any circumstance where a thermosetting material also requires compression in order to arrive at the final component.

The filler component **20** can be made of any suitable material but is envisaged that it is likely to be made from an appropriate plastics material, for example nylon.

The invention claimed is:

1. A curable assembly, which, upon the application of curing conditions will form a completed component or part component, the assembly comprising:

a first curable sub-assembly part of composite fibre-reinforced, resin matrix material,

a second curable sub-assembly part of composite fibre-reinforced, resin matrix material arranged against the first curable piece, a filler component arranged between the first and the second curable sub-assembly parts, the filler component formed from a material which is rigid relative to the material of the first and second curable sub-assembly parts before curing, whereby the filler component is arranged to be secured between the first and second curable sub-assembly parts on application of curing conditions so as to form the completed component or part component,

the filler component having a first elongate member which has a cross section in the form of a concave ogive defining a first surface having a first profile and a second substantially opposite surface having a second profile, the first surface profile being shaped to fit against the first curable sub-assembly part, the second surface profile being shaped to fit against the second curable sub-assembly part, the filler component having a second elongate member arranged at a right angle to the first elongate member and having a cross section in the form of a part annulus such that the first elongate member and the second elongate member share a common plane, the filler component being arranged to apply or to react to a tooling load of at least one of the first or second surfaces during curing.

2. A filler component as claimed in claim **1**, wherein the first profile is a first radius.

3. A filler component as claimed in claim **2**, wherein the second profile is a second radius.

4. A filler component as claimed in claim **3**, wherein the first radius is larger than the second radius.

5. A filler component as claimed in claim **2**, wherein the first curable sub-assembly has a corresponding radius that is larger than the first radius.

6. A filler component as claimed in claim **3**, wherein the second curable sub assembly has a corresponding radius which is larger than the second radius.

7. A filler component configured to be arranged, in use, between and at least partially exposed of first and second curable sub-assembly parts, the filler component having a first elongate member which has a cross section in the form of a concave ogive defining a first surface having a first profile and a second substantially opposite surface having a second profile, the first surface profile being shaped to fit against the first curable sub-assembly part, the second surface profile being shaped to fit against the second curable sub-assembly part, the filler component having a second elongate member arranged at a right angle to the first elongate member and having a cross section in the form of a part annulus such that the first elongate member and the second elongate member share a common plane, the filler component being arranged to apply or to react to a tooling load of at least one of the first or second surfaces during curing and wherein the filler component is arranged to remain between the first and the second sub-assembly parts after curing.

8. A filler component as claimed in claim **7**, wherein the filler component is preferably arranged to apply or to react a tooling load at both of the first and second surfaces.

9. A filler component as claimed in claim **7**, wherein the filler component comprises three mutually orthogonal members as in X, Y and Z axes in a Cartesian reference frame.

10. A filler component as claimed in claim **7**, wherein the second elongate member is arranged relative to the first elongate member to provide a flat surface against which a curable piece of fibre-reinforced epoxy resin matrix material can be arranged.

11. A filler component as claimed in claim **7**, wherein the filler component comprises two of said first elongate members arranged at right angles to each other and two of said second elongate members extending from the point at which the first elongate members intersect, on opposite sides thereof.

12. A filler component configured to be arranged, in use, between and at least partially exposed to first and second curable sub-assembly parts, the filler component having a first elongate member which has a cross section in the form of a concave ogive defining a first surface having a first profile and a second substantially opposite surface having a second profile, the first surface profile being shaped to fit against the first curable sub-assembly part, the second surface profile being shaped to fit against the second curable sub-assembly part, the filler component is L-shaped having a second elongate member arranged at a right angle to the first elongate member and having a cross section in the form of a part annulus, the filler component being arranged to apply or to react to a tooling load of at least one of the first or second surfaces during curing and wherein the filler component is arranged to remain between the first and the second sub-assembly parts after curing.

13. A filler component configured to be arranged, in use, between and at least partially exposed to first and second curable sub-assembly parts, the filler component having a first elongate member which has a cross section in the form of a concave ogive defining a first surface having a first profile and a second substantially opposite surface having a second profile, the first surface profile being shaped to fit against the first curable sub-assembly part, the second surface profile being shaped to fit against the second curable sub-assembly part, the filler component is T-shaped having a second elongate member arranged at a right angle to the first elongate member and having a cross section in the form of a part annulus, the filler component being arranged to apply or to react to a tooling load of at least one of the first or second surfaces during curing and wherein the filler component is arranged to remain between the first and the second sub-assembly parts after curing.

14. A method of forming a completed component or part component, the method comprising the steps of:

providing a first curable sub-assembly part of composite fibre-reinforced resin matrix material,

providing a second curable sub-assembly part of composite fibre-reinforced resin matrix material,

providing a filler component formed from material which is rigid relative to the composite fibre-reinforced resin matrix material before it is cured,

arranging the filler component between the first and second curable sub-assembly parts of composite fibre-reinforced resin matrix material to provide a curable sub-assembly,

applying a curing tool to the sub-assembly to apply heat and pressure to the sub-assembly, whereby the filler component reacts to pressure applied to the surface assembly to apply consolidating pressure to the face of the composite fibre-reinforced resin matrix material arranged away from the curing tool, and retaining the filler component as part of the completed component or part component,

the filler component having a first elongate member which has a cross section in the form of a concave ogive defining a first surface having a first profile and a second substantially opposite surface having a second profile, the first surface profile being shaped to fit against the first curable sub-assembly part, the second surface profile being shaped to fit against the second curable sub-assembly part, the filler component having a second elongate member arranged at a right angle to the first elongate member and having a cross section in the form of a part annulus such that the first elongate member and the second elongate member share a common plane.

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